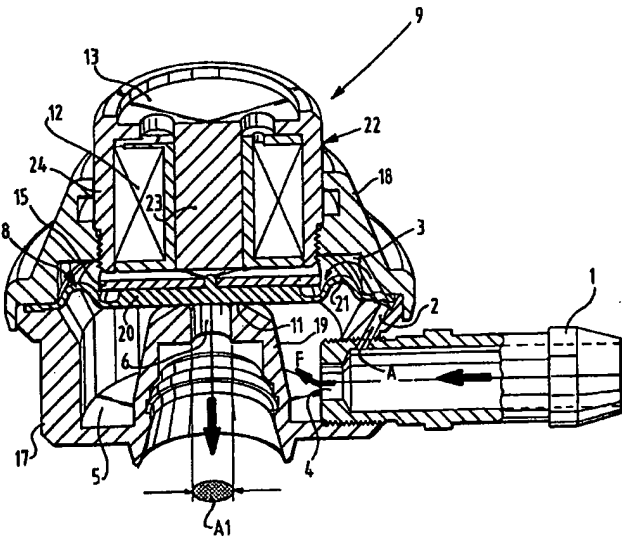


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(54) Title: METERING VALVE AND FUEL SUPPLY SYSTEM EQUIPPED THEREWITH			
			
(57) Abstract			
<p>The invention relates to a metering valve (9) for a fluid, provided with a housing with a metering opening and a movable closing member. The closing member (8) is biased to one of its positions by biasing means co-acting therewith in the form of a pneumatic or hydraulic spring, and can be placed in another position counter to the bias by operating means. The pneumatic or hydraulic spring can herein be driven by the fluid for metering. The closing member (8) can be a diaphragm with a relatively stiff central portion (20) and a relatively flexible edge portion (21). A supply opening connected to a feed conduit (1) for the fluid for metering can be arranged in the housing on either side of the diaphragm. The invention further relates to a system for supplying fuel to a combustion engine, provided with a container for the fuel and a feed line connecting the container to the engine, in which line is received one or more metering valves of the above described type.</p>			

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**METERING VALVE AND FUEL SUPPLY SYSTEM EQUIPPED THEREWITH**

The invention relates to a valve for metering a fluid, provided with a housing with at least one metering opening and at least one closing member which is movable between a position closing the opening and a position  
5 leaving the opening at least partially clear, which closing member is biased by biasing means co-acting therewith to one of its positions and can be placed in the other position counter to the bias by operating means. Such a metering valve is known and is used for  
10 instance in fuel injection systems, particularly systems for injecting gaseous fuel, such as the LPG injection system marketed by applicant under the name DGI.

Current metering valves or vapour injectors are provided with a closing member or plunger which is pulled  
15 from the seat by an electromagnet counter to the force of a mechanical spring and which is pressed by the spring back onto the seat after the electromagnetic force has been removed. Because the plunger must be opened counter to a spring force, the force required of the  
20 electromagnet is greater than should actually be necessary. Both the electromagnetic coil and the plunger must hereby be embodied disproportionately larger and heavier than would be necessary in the absence of the spring.

25 The unnecessarily heavy plunger causes problems in respect of the so-called rebound, i.e. the rebound which occurs when the heavy plunger strikes at great speed against the upper stop at the end of the attractive phase of the electromagnet. This phenomenon of rebound results  
30 in a non-linear and unstable metering behaviour, which is furthermore temperature and injector-dependent. As a result it is not easily possible to produce this type of vapour injector in large numbers with sufficient precision.

In the DGI system of applicant already mentioned above, this problem is solved by using a control of the vapour injector with feedback, whereby variations in the metering behaviour as a result of rebound are measured  
5 and can be corrected by feedback. However, this system is relatively expensive and therefore particularly suitable for group injection or monopoint injection, wherein a single central injector is present for metering of the gas, which is then guided alternately to the desired  
10 cylinders via a nozzle.

The invention therefore has for its object to provide an improved metering valve which is simpler, smaller and lighter than the known valve and which can thus be manufactured at lower cost. Such a valve would  
15 then be suitable for application in a system of individual injection per cylinder, or a multipoint injection system.

According to the invention this is achieved in that the biasing means comprise at least one pneumatic or  
20 hydraulic spring. Preferred embodiments of the metering valve according to the invention form the subject-matter of the dependent claims.

Owing to the pneumatic (or hydraulic) closing of the valve, preferably a diaphragm, optionally in combination  
25 with the electromagnetic opening thereof, the use of spring force becomes unnecessary. The coil and the plunger can hereby take a small and light form such that the problem of rebound no longer occurs. The pneumatic or hydraulic spring is preferably operated by the fluid  
30 for metering. By using the fluid itself to operate the valve a simple and robust construction is obtained with relatively few components.

The operating means can advantageously be of electromagnetic type, whereby a simple control is  
35 possible. The operating means can herein then comprise a coil with U-shaped armature and at least one metal attraction element connected to the closing member. This attraction element is preferably plate-like. Thus, as a

result of the chosen embodiment with the U-shaped armature and flat plunger plate, a relatively small electromagnetic force is required, so that a so-called high-impedance coil can suffice. This has the further  
5 consequence that the electrical control can be provided using a simple low side driver, such as is also known from modern petrol injection systems. If the metering behaviour of the valve were made the same as that of a petrol injector, it would even be possible to control the  
10 valve directly from the engine management computer of the petrol engine.

The closing member is preferably formed by a diaphragm. Such a diaphragm is light and of simple construction and can be operated with little force. The  
15 diaphragm then advantageously has a relatively stiff central portion co-acting with the opening for closing, and a relatively flexible edge portion. A good sealing and yet easy deformability of the diaphragm are thus obtained simultaneously.

20 The closing member can be accommodated in a housing which has on either side of the closing member at least one supply opening connected to a feed conduit for the fluid for metering. The closing member can thus be operated by admitting fluid on either side thereof. The  
25 supply openings are preferably dimensioned herein such that the fluid pressure in the housing on the side of the closing member directed toward the opening for closing is lower than the pressure on the opposite side thereof.

The invention further also relates to a system for  
30 supplying fuel to a combustion engine, provided with a container for the fuel and at least one feed line connecting the container to the engine, in which line is received at least one metering valve of the above described type. The engine herein preferably has a number  
35 of combustion chambers and at least one metering valve is present for each combustion chamber. A precisely operating multipoint injection system is thus obtained

which can be manufactured in simple manner and at low cost.

The invention will now be elucidated on the basis of an embodiment, wherein reference is made to the annexed 5 drawing, in which:

fig. 1 is a cross-sectional perspective view of a metering valve according to the invention, and

fig. 2 shows schematically the structure of a fuel supply system in which such a metering valve is arranged 10 for each cylinder.

A metering valve 9 (fig. 1) comprises a housing which consists of a base part 17 and a cover 18 placed sealingly thereon. A closing member 8 is arranged between cover 18 and base part 17 whereby the interior of the 15 housing is divided into a control chamber 3 and a through-flow chamber 5. This through-flow chamber 5 is connected to a gas supply line 1 and a gas discharge line (not shown here). The gas discharge line is herein received in a connecting piece 19 to which through-flow 20 chamber 5 is connected via an outlet opening 6. Around this outflow opening 6 is formed an annular valve seat 11 against which closing member 8 lies sealingly.

Closing member 8 here takes the form of a circular plastic diaphragm with a relatively stiff central portion 25 20 which co-acts with seat 11 around outlet opening 6 and a relatively flexible edge portion 21 situated round central portion 20. This edge portion 21 takes a curved form in cross-section, whereby it allows relatively large movements of central portion 20. Fixed onto central 30 portion 20 is a plate-like metal attraction element 15 which forms part of the operating means for closing member 8. These operating means further comprise an electromagnet 22 formed by an armature 13 and a coil 12 wound therearound. Armature 13 herein comprises a core 23 35 and a cylindrical part 24 and therefore has in cross-section the form of a reverse W-shape or a pair of reverse U-shapes.

Both through-flow chamber 5 and control chamber 3 lying thereabove are connected to gas supply line 1. Recessed for this purpose in the wall of base part 17 and in the wall of cover 18 is a branch line 2 through which the fluid supplied through line 1 can flow to the control chamber. Further arranged between gas supply line 1 and through-flow chamber 5 is a narrowed passage or 'throttle' 4, the function of which is described below.

The metering valve 9 according to the invention now operates as follows. Vaporous fuel is supplied from an evaporator 10 via a conduit 7 (fig. 2) to the gas supply line 1 and flows via passage 4 to through-flow space 5 beneath closing member 8. A part of the fuel simultaneously flows through branch channel 2 to control space 3 above diaphragm 8. The same gas pressure herein prevails on either side of diaphragm 8. On the upper side this pressure acts on the entire surface area of the diaphragm but on the underside only on the part of diaphragm 8 outside the seat 11. As a consequence of the thereby created difference in area A1, a closing force is generated whereby closing member 8 is pressed onto seat 11 and held fixedly in a position closing off outlet opening 6 of valve 9.

When the coil 12 of the electromagnet above closing member 8 is energized, an electromagnetic force is created between the armature 13 of coil 12 and the metal plate 15 fixed onto closing member 8. Closing member 8 is hereby pulled against armature 13 and outlet opening 6 is left clear. The vaporous fuel then flows from supply line 1 via passage 4 to outlet opening 6, which debouches via the discharge line (not shown) into the inlet manifold 14 of an associated cylinder of a combustion engine 16.

The narrowed passage 4 herein functions as 'throttle' or differential pressure regulator, whereby as a result of the flow of the fuel a pressure difference is generated between the through-flow chamber 5 beneath the diaphragm-like closing member 8 and the control chamber 3 thereabove. The downward directed suction force which is

the result of the pressure difference is however overcome in this situation by the upward directed force which electromagnet 22 exerts on closing member 8. As soon as coil 12 is no longer energized however, the downward  
5 directed suction force immediately results in a downward directed displacement of closing member 8 to seat 11, whereby opening 6 is closed.

As a result of the simple and therefore low-cost construction thereof, the above described metering valve  
10 9 can, as stated, be used advantageously in a system of individual injection per cylinder, i.e. a multipoint injection system as shown in fig. 2. It is however also conceivable to apply valve 9 as single metering valve in a system with central fuel injection.

15 The invention is not limited to the above discussed embodiments and the scope of the invention is therefore defined solely by the following claims.



7  
CLAIMS

1. Valve for metering a fluid, provided with a housing with at least one metering opening and at least one closing member which is movable between a position closing the opening and a position leaving the opening at least partially clear, which closing member is biased by biasing means co-acting therewith to one of its positions and can be placed in the other position counter to the bias by operating means, **characterized in that** the biasing means comprise at least one pneumatic or hydraulic spring.

2. Metering valve as claimed in claim 1, **characterized in that** the pneumatic or hydraulic spring is driven by the fluid for metering.

3. Metering valve as claimed in claim 1 or 2, **characterized in that** the operating means are of electromagnetic type.

4. Metering valve as claimed in claim 3, **characterized in that** the operating means comprise a coil with U-shaped armature and at least one metal attraction element connected to the closing member.

5. Metering valve as claimed in claim 4, **characterized in that** the attraction element is plate-like.

6. Metering valve as claimed in any of the foregoing claims, **characterized in that** the closing member is a diaphragm.

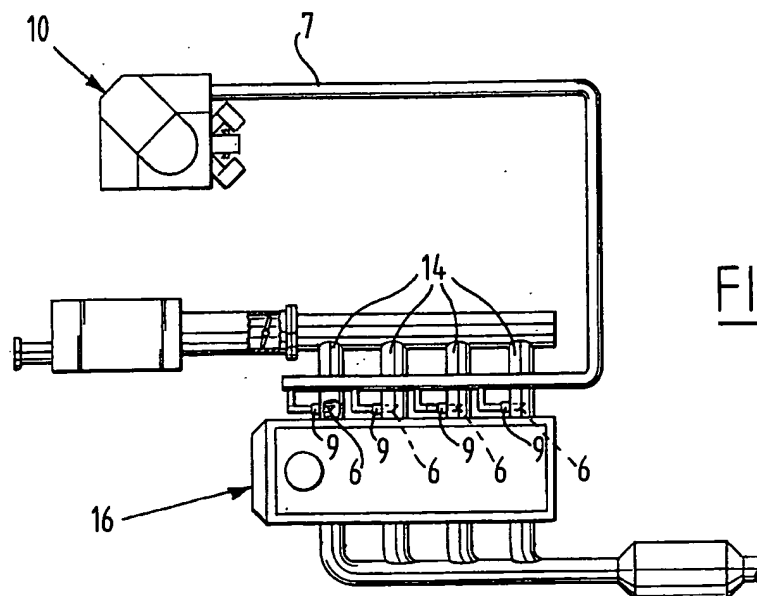
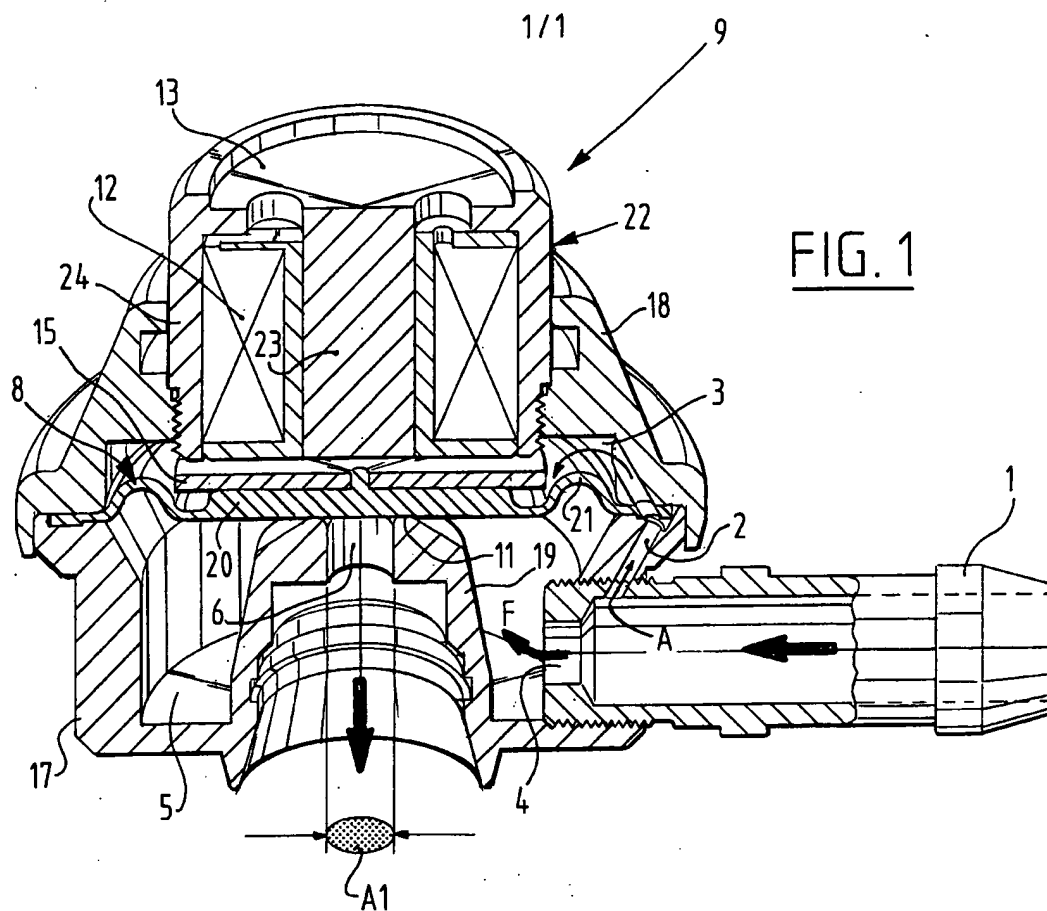
7. Metering valve as claimed in claim 6, **characterized in that** the diaphragm comprises a relatively stiff central portion co-acting with the opening for closing, and a relatively flexible edge portion.

8. Metering valve as claimed in any of the foregoing claims, **characterized in that** the closing member is accommodated in a housing which has on either side of the closing member at least one supply opening connected to a feed conduit for the fluid for metering.

9. Metering valve as claimed in claim 8,  
**characterized in that** the supply openings are dimensioned  
such that the pressure of the fluid in the housing on the  
side of the closing member directed toward the opening  
5 for closing is lower than the pressure on the opposite  
side thereof.

10. System for supplying fuel to a combustion  
engine, provided with a container for the fuel and at  
least one feed line connecting the container to the  
10 engine, in which line is received at least one metering  
valve as claimed in any of the foregoing claims.

11. Fuel supply system as claimed in claim 10,  
**characterized in that** the engine has a number of  
combustion chambers and at least one metering valve is  
15 present for each combustion chamber.



# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 99/04036

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 F16K31/06

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 F02M F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 26 15 917 A (DAIMLER-BENZ) 23 February 1978 (1978-02-23) page 2, paragraph 1 -page 3, paragraph 3 page 4, paragraph 3 page 5, paragraph 2 -page 6, line 4 page 6, paragraph 4 -page 7, line 8 ---	1,2,10, 11
X	WO 89 04920 A (GAS OUTBOARDS INT.) 1 June 1989 (1989-06-01) page 1, line 3 - line 7 page 5, line 25 -page 6, line 21; figure 1 ---	1-3,10, 11
X	US 4 500 067 A (ZUKAUSKY) 19 February 1985 (1985-02-19) abstract column 3, line 53 - line 68; figure 1 --- -/--	1-3,6-9

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Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 430 978 A (LEWIS) 14 February 1984 (1984-02-14) column 6, line 52 -column 7, line 36; figure 2 ---	1-3, 10, 11
X	US 5 408 967 A (FOSTER) 25 April 1995 (1995-04-25) column 2, line 40 - line 45 column 2, line 55 - line 62; figure 1 ---	1, 10, 11
X	DE 23 57 263 B (BOSCH) 8 August 1974 (1974-08-08) column 2, line 54 -column 3, line 27 column 3, line 66 -column 4, line 48; figure 1 ---	1, 2, 6, 8, 10, 11
X	DE 35 40 997 A (BOSCH-SIEMENS HAUSGERÄTE) 21 May 1987 (1987-05-21) column 2, line 51 - line 66; figure 1 ---	1, 2, 6-9
X	FR 946 891 A (BENDIX) 28 June 1949 (1949-06-28) page 3, line 72 -page 4, line 44 ---	1, 2, 6-8
X	WO 98 08014 A (KAVLICO CORP) 26 February 1998 (1998-02-26) page 6, line 17 -page 8, line 15; figure 2 ---	1-5, 10, 11
X	US 5 031 841 A (SCHÄFER) 16 July 1991 (1991-07-16) column 2, line 51 -column 3, line 2 column 3, line 13 - line 56; figure 1 ---	1, 2, 6
X	GB 1 450 402 A (BOSCH) 22 September 1976 (1976-09-22) page 1, line 37 - line 51 page 2, line 23 - line 32 page 2, line 51 - line 54 page 2, line 58 - line 90; figure 2 -----	1-3, 6, 8-11

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 99/04036

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2615917 A	23-02-1978	NONE	
WO 8904920 A	01-06-1989	AU 630082 B AU 2805589 A EP 0387288 A US 5076244 A	22-10-1992 14-06-1989 19-09-1990 31-12-1991
US 4500067 A	19-02-1985	CA 1198649 A JP 59147177 A	31-12-1985 23-08-1984
US 4430978 A	14-02-1984	NONE	
US 5408967 A	25-04-1995	NONE	
DE 2357263 B	08-08-1974	AT 331574 B AT 916074 A AU 7535874 A BR 7409475 A FR 2257795 A GB 1498107 A JP 50079623 A SE 401020 B SE 7414322 A US 3942497 A	25-08-1976 15-11-1975 20-05-1976 25-05-1976 08-08-1975 18-01-1978 28-06-1975 17-04-1978 20-05-1975 09-03-1976
DE 3540997 A	21-05-1987	NONE	
FR 946891 A	28-06-1949	NONE	
WO 9808014 A	26-02-1998	US 5758865 A	02-06-1998
US 5031841 A	16-07-1991	DE 4005455 A GB 2228769 A,B	30-08-1990 05-09-1990
GB 1450402 A	22-09-1976	DE 2246624 A FR 2163246 A JP 49070224 A SE 386482 B	28-03-1974 20-07-1973 08-07-1974 09-08-1976

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